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ABSTRACT

An analysis was performed of multiple-choice tests in terms of the frequency theory of recognition memory. High and low ability children listened to sentences under different instructional sets (imagery rating and sentence repetition) and were later tested with multiple-choice alternatives: (1) either identical or similar in meaning to the originally presented correct items, and (2) either including or not previously presented irrelevant information. The sources of interference anticipated from the theory were evident in both experiments. Moreover, instructional sets moderated frequency effects in the anticipated manner for lower ability children. Theoretical and educational implications are discussed. (Author)

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Processes Affecting Children's Learning from Sentences[1]

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Processes Affecting Children's Learning from Sentences[1]

The research which I shall report deals with processes involved in children's recognition memory for information contained in sentences. In this research we have utilized a recognition test procedure closely resembling the multiple-choice tests commonly found in schools. I shall first describe the rationale and general procedure utilized in the research and then describe the results of two experiments conducted thus far.

Typically, children (4th and 5th graders) listen to 20 unrelated, complex sentences such as The lady showed her ticket and demanded the seat. They are then tested 24 hours later for their retention of the contents of the sentences. By systematically manipulating the form of the correct alternatives and the nature of the incorrect alternatives on the recognition test items we hoped to be able to assess children's degree of comprehension of the original material and to identify sources of interference in memory.

Manipulations of Correct Alternatives

The rationale underlying our manipulations of the form of the correct alternatives in test items derives from Richard Anderson's (1972) suggestion that questions based on paraphrases---rather than verbatim copies---of the originally presented material will distinguish between students who have truly comprehended the material and those who have not.

Anderson's remarks and research have focussed on questions designed to elicit short-answer recall on the part of students. In our research using multiple-choice recognition tests we have incorporated Anderson's paraphrase-verbatim manipulation by including among test item options either the verbatim-correct word from the original sentence or a synonym substitution. For example, (see Table 1 in your handouts) for the sentence, The lady showed her ticket and demanded the seat, the item stem is the same in all conditions (e.g. What did the lady demand?) but for verbatim items the correct alternative is the seat and for synonym items the correct alternative is the chair. We would expect children who have fully comprehended the original sentences to do better on the synonym variations than children who have comprehended them less well. However, performance for subjects differing on comprehension should not differ for the verbatim items.

Manipulations of Incorrect Alternatives

The rationale underlying our manipulations of the nature of incorrect alternatives on the recognition test derives from the frequency theory of recognition memory (Underwood, 1972). Briefly, the major tenet of the theory is that recognition decisions are based on subjective frequency differentials between old and new items--the old items having a frequency of 1 and new items a frequency

of 0. A straightforward prediction of the theory is that including old-incorrect words from the sentences as distractors on test items should produce interference as compared to items in which all distractors are new words. For example, (see Table 1 in handout) the test items (V-OP and S-OP) which contain the old-incorrect alternative (the ticket) should produce more errors than test items (V-OA and S-OA) which do not contain this old information according to frequency theory. On the other hand, if subjects are engaged in processing the meanings of sentences as a whole, then perhaps frequency does not play a role in recognition of information conveyed in sentences.

Manipulations of correct and incorrect alternatives thus resulted in four test-item types (as shown in Table 1--V-OA, V-OP, S-OA and S-OP), with 5 sentences being tested by means of each test-item type. Four test versions were created with sentences being rotated through test-item types. As shown in Table 1, for half of the sentences, a "what" question was appropriate. For the other half a "who" question was appropriate. Each sentence was constructed so that it contained a word which was a plausible but incorrect response to the later test question. The sentences were presented to subjects via a tape recorder at a seven-second rate. A day later the questions and responses were read to subjects while they followed along on printed tests. Subjects circled a response for each question. To alert subjects to the

synonym options they were told to circle an answer even if it was not exactly the same as the word that was used on the previous day--as long as it meant the same thing.

Experiment I

The first experiment that we conducted represented an initial attempt to test the notions that: (1) subjects with good comprehension of the original material would perform better than subjects with poor comprehension on synonym but not verbatim items, and (2) poor comprehenders would be more susceptible than good comprehenders to interference from old-incorrect information. We attempted to vary degree of comprehension by using an incidental learning format with different orienting tasks. In the repetition condition, subjects were told to listen for a pause in each sentence and then to repeat the sentence aloud "exactly the same way" the speaker had said it. In recording the sentences the speaker inserted a noticeable pause at one predetermined clause boundary within each sentence. Subjects in the imagery condition were told to rate each sentence on its imageability. It was expected that these imagery and repetition instructions would orient subjects respectively toward and away from the semantic content of the sentences. Twenty Ss (equally divided between fourth and fifth grades) were randomly assigned to each instructional condition.

Results

The results of Experiment 1 provided encouragement but not complete confirmation of our hypotheses. Performance was worse on synonym items than on verbatim items for all subjects. Moreover, the largest difference between imagery and repetition subjects occurred on synonym items. However, instructions did not interact with item types. Also, old-present item types produced more errors than old-absent types with a conditional error analysis indicating that the errors were predominantly localized in the old alternatives. However, once again, interference effects were evident for both instructional conditions. These results at least indicated to us that frequency processes operate in recognition memory for sentences (as well as in simple word recognition situations).

That the instructional variable did not interact as expected with item type is perhaps not too surprising when one considers that the experiment was conducted in a university community school that was over-represented by high achieving students. Our repetition instructions may not have been powerful enough to induce nonsemantic processing of sentence materials in this population of students.

Experiment 2

In Experiment 2, we remedied this problem by sampling from a rural school that contained students spanning a wide range of academic achievement. Forty children from two combined third-and fourth-grade classrooms were randomly assigned (in equal numbers) to the two instructional

conditions (repetition and imagery). After the experiment was completed, the children were divided into "high" and "low" achievement groups on the basis of their being above or below the national median on available standardized achievement test information (i.e., STEP and Cooperative Primary). Coincidentally it was found that exactly half of the students were above and half were below. However, due to the post-experimental division of the children, slightly different numbers of students ended up in the four Achievement by Instructions groups that were formed (two had 11 and two had 9).

The predictions parallel those made for Experiment 1, only now good and poor comprehension is indexed in two ways: High versus low achievement levels and Imagery versus Repetition instructional conditions.

Results

The mean number of errors, expressed as percentages are presented for each item type in Table 2 of your handout. A 2(achievement level) X 2(instructions) analysis of variance was carried out for each item type. For both verbatim item types (V-OA and V-OP) there was no significant difference between low and high achievers nor was there a significant difference between repetition and imagery. In contrast, there was a significant difference between high and low achievers for the S-OA item type ($t(36) = 2.09$, $p < .05$) and S-OP item type ($t(36) = 2.57$ $p < .05$).

A significant difference between instructional conditions was found only for the S-OP item type ($t(36) = 2.70$ $p < .01$). Hence, given the assumption that low achievers are less inclined than are high achievers to process the to-be-learned material semantically, synonym items, but not verbatim items provide a valid assessment of comprehension. In the present sample, the presumed differences in processing by high and low achieving students is mimicked (although not perfectly) by instructional conditions which presumably vary in the efficiency of semantic processing they induce.

With respect to interference effects, the results displayed in Table 2 are less clear. There is an overall tendency toward more errors on old-present items. However, this increase is not systematically modified by achievement level or instructions. However, an interesting finding emerges when one considers the types of errors made on the old-present item type (i.e., S-OP) which differentiates between high- and low-achievers. In Table 3 of your handout is presented the mean percentage of all S-OP errors that involved the familiar distractor. To analyze these error patterns, for each child a difference between "old" and "new" errors was computed. These data were then analyzed in a 2 x 2 ANOVA. Consistent with the picture portrayed in Table 3, given that an S-OP error was made, low achievers were much more likely than high achievers to select the familiar distractor ($t(36) = 2.64$, $p < .01$). Neither the instructions effect nor the interaction approached significance.

Conclusion

Two tentative conclusions are supported by the present research:

1. Synonym correct alternatives in multiple-choice tests discriminate between students who process the original material at the level of comprehension and students who do not. Further research is directed toward substantiating this conclusion by sampling children of even lower ability levels than used currently.

2. Interference effects predicted by frequency theory do occur in recognition tests following sentence learning. Moreover, the detrimental effects of including familiar distractors appear to be disproportionately high for low achieving students. The significance of this finding is that including such familiar distractors in multiple-choice tests results in bias toward low achieving students. That is, low achieving children who are most likely to make an error on a synonym item are also drawn systematically to the familiar distractors. A disturbing implication from frequency theory (as yet untested) is that "old" errors are likely to persist in long-term memory to the potential detriment of low-achieving students.

Footnotes

1. This research was funded by the Wisconsin Research and Development Center for Cognitive Learning, supported in part as a research and development center by funds from the National Institute of Education. The opinions herein do not necessarily reflect the position or policy of the National Institute of Education and no official endorsement by the Institute should be inferred (Center No. NE-C-00-3-0065). We are grateful to Dr. Michael J. Subkoviak and Joseph Guttmann for their inputs to this work.

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Table 1

Illustrations of Sentences and Test Items

Study Sentence: The lady showed the ticket and demanded the seat.

Test Stem: What did the lady demand?

Response Options:

(V-OA) Verbatim-Old Absent	(V-OP) Verbatim-Old Present	(S-OA) Synonym-Old Absent	(S-OP) Synonym-Old Present
the seat	the seat	the chair	the chair
the money	the ticket	the money	the ticket
the telephone	the telephone	the telephone	the telephone

Study Sentence: The lawyer swore that the richman slapped the actor.

Test Stem: Who slapped the actor?

Response Options:

Verbatim-Old Absent	Verbatim-Old Present	Synonym-Old Absent	Synonym-Old Present
the richman	the richman	the millionaire	the millionare
the director	the lawyer	the director	the lawyer
the pilot	the pilot	the pilot	the pilot

Table 2

Mean Percentage of Errors on Each Item Type

Verbatim - Old Absent

	Imagery	Repetition
High	37.8	24.1
Low	47.3	35.6

Verbatim - Old Present

Imagery	Repetition
44.4	49.1
32.7	44.4

Synonym - Old Absent

	Imagery	Repetition
High	35.6	50.9
Low	47.3	64.4

Synonym - Old Present

Imagery	Repetition
46.7	45.4
56.4	71.1

Table 3

Mean Percentage of Errors Involving Familiar Distractors

(Synonym-Old Present Item Type)

	Imagery	Repetition
High	38.1	48.1
Low	64.5	75.0